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A NO. TA(AG) 03-75

TING MEDIUM FROM MIXED TROPICAL HARDWOOD SEMICHEMICAL PULPS

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FOREST PRODUCTS LABORATORY

November 1977

LIMITED DISTRIBUTION

[redacted]

AID Report No. 15

FOREST PRODUCTS LABORATORY

MADISON, WISCONSIN - 53705

UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

In Cooperation with the University of Wisconsin

CORRUGATING MEDIUM FROM MIXED TROPICAL HARDWOOD SEMICHEMICAL PULPS

By

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Summary

Pilot-scale semichemical pulps were made from mixtures of tropical hardwoods by the neutral sulfite, kraft, green liquor, and soda-carbonate processes. These pulps were converted into nominal 26-pound-per-1,000-square-foot corrugating medium on the Forest Products Laboratory experimental Fourdrinier papermachine. The mediums were evaluated for resistance to fracturing on the Forest Products Laboratory corrugator by increasing the speed from 0 to 600 feet per minute with a minimum of sheet tension and then increasing the sheet tension while at a constant speed of 600 feet per minute.

Most mediums failed to corrugate at less than 20 feet per minute with a minimum of sheet tension. Decreasing the neutral sulfite pulp yield from 74 to 65 percent, refining the pulp more to give better bonding, and lowering the papermachine headbox consistency to give a

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1/ Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

better formed sheet did not improve runnability through the corrugator. Increasing the sulfidity of the kraft pulping liquor from 25 to 50 percent was also found to be ineffective. Surface frictional tests, microscopic examinations, and chemical analysis failed to reveal causes for the poor performance through the corrugator.

Adding oleic acid to the papermachine furnish to act as a lubricant or by passing the medium over polyethylene bars as it was being fed to the corrugator were found to be effective methods of overcoming this runnability deficiency of corrugating mediums made from mixed tropical hardwoods.

Background

The results of previous handsheet testing of 75 percent yield NSSC pulps made from mixtures containing either Philippine, Ghanaian, or Colombian hardwoods indicated that good quality corrugating medium in regard to sheet properties could be made on the papermachine. See AID Report No. 1, "Exploratory Kraft and NSSC Pulping of 50 Philippine Hardwoods," AID Report No. 7, "Ghanaian Hardwood Mixtures for Pulp and Paper," and AID Report No. 8, "Exploratory Kraft and NSSC Pulping and Production of a Bleached, Market-Grade, Kraft Pulp from Colombian Hardwood Mixtures." It was also indicated in AID Report No. 8 that corrugating medium with improved quality could be obtained by adding caustic soda to the NSSC cooking liquors and/or by reducing pulp yield.

As shown in AID Report No. 9, "Linerboard, Corrugating Medium, and Corrugated Containers from Mixtures of Philippine Hardwoods," and in AID

Report No. 14, "Linerboard, Corrugating Medium, and Corrugated Containers from Mixtures of Colombian Hardwoods," good quality corrugating mediums were made on the papermachine from 75 percent yield NSSC pulps of these mixtures. However, the definition of good quality here was based on the results of usual paperboard tests made on this particular product. Unfortunately, these tests do not necessarily correlate with runnability of the medium through the singlefacer as both mediums failed. Severe cracking occurred while fluting at less than 20 feet per minute with minimum tension.

Chip Mixtures

For most of the pilot scale digestions, the Colombia A mixture described in AID Report No. 8 was used. However, because of a shortage of the Colombia mixture, another mixture containing not only Colombian, but also Philippine and Ghanaian hardwoods was made. The composition of this mixture is shown in table 1. The weighted average specific gravity of this mixture was 0.562, slightly higher than that of the Colombia mixture which was 0.510.

Pulping

Neutral sulfite, kraft, green liquor, and soda-carbonate pulping processes were used to produce pilot-scale semichemical pulps for conversion into corrugating medium on the papermachine. The various pulping conditions used are given in table 2. With few exceptions, the following procedures were used. At the end of cooking, the liquor was blown from

the digester and, without washing, the cooked chips were fiberized at about 18 percent consistency in a 36-inch-diameter, double-rotating disk mill to a Canadian Standard freeness of about 700 milliliters. The fiberized pulps were diluted with hot water to about 2 percent consistency, screened through a 0.012-inch slotted flat screen, wet-lapped, and crumbed before refining at about 12 percent consistency in the same disk mill to a Canadian Standard freeness of about 350 milliliters.

Neutral Sulfite Semichemical Pulping

Because it was known from previous small scale NSSC digestions of the Colombian mixture that improved properties could be obtained by either adding caustic soda to the cooking liquor or by reducing yield, pilot scale digestions were made to do both. Three percent caustic soda was added to the cooking liquor while the time at cooking temperature was reduced from 90 to 70 minutes to maintain the yield at about 75 percent. The yield was lowered to about 65 percent by increasing the amount of cooking chemicals and the time at cooking temperature. Digestions were also made with the Colombian mixture at the 65 percent yield level in which all of the sodium carbonate buffer was replaced with sodium sulfide. In order to study a wide range of stock preparation and papermachine variables, 12 pilot scale digestions were made at the 60 percent yield level using the mixture containing woods from all three countries. One other NSSC pulp at 74 percent yield was made from this mixture for a papermachine trial involving the addition of 25 percent fully cooked kraft pulp made from the same mixture.

Kraft Semichemical Pulping

As reported in AID Report No. 14, good quality corrugating medium was made from the screenings of high yield kraft digestions of the Colombian mixture. This medium was successfully fluted on the singlefacer double faced, and eventually converted into boxes. In this study pilot scale kraft semichemical pulps were made from both the Colombian mixture and the mixture containing woods from all three countries. These were made to the same Kappa number as the high yield kraft screenings. Another kraft semichemical pulp was made at this Kappa number from the Colombian mixture using a pulping liquor with 50 percent instead of the usual 25 percent sulfidity. The effect of lowering the yield from about 67 percent to about 59 percent was determined by making an additional kraft semichemical digestion of the mixture containing woods from all three countries.

Green Liquor Semichemical Pulping

In the first attempts at making this type pulp from the Colombian mixture the cooking liquors contained the same amount of effective alkali as the kraft liquors which earlier gave semichemical pulps at the Kappa number level of the high yield kraft screenings. Effective alkali is the sum of the NaOH and half of the Na_2S expressed on a Na_2O basis. However, this was far too much chemical and the yields were only about 60 percent. Additional green liquor semichemical pulps were subsequently made using both the Colombian mixture and the mixture containing woods from all three countries with much less total chemical. These latter digestions were more in line with commercial green liquor semichemical pulping practices.

Soda-Carbonate Semichemical Pulping

One pilot scale digestion was made using the Colombian mixture to produce a semichemical pulp with a yield of about 69 percent.

Papermaking

Nominal 26-pound-per-1,000-square-foot corrugating mediums were made on the experimental Fourdrinier papermachine from the pulps described in table 2. In most of these runs the refining and machine conditions were maintained as near constant as possible to determine effect of pulp yield and pulping process on runnability. However, there were some differences in headbox consistency as shown in tables 3 and 4. These represent differences in fines passing through the wire since the papermachine speed and the rates of stock furnish and white water to the machine were all held constant. In one run (MR 7175, table 3), 0.25 percent oleic acid (based on the dry weight of pulp) was added to the pulp furnish in an attempt to change the surface frictional resistance of the medium. This run plus its control (MR 7174) were made using dry broke from previous runs. A series of runs (MR 7169-7173) were made varying headbox consistency and degree of pulp refining.

All corrugating mediums were evaluated for physical properties according to TAPPI standard methods except tensile properties which were made with a universal tester equipped with an electrical load cell.

Corrugating

Each of the mediums were evaluated for resistance to fracturing on the Forest Products Laboratory 20-inch corrugator by increasing the speed from 0 to 600 feet per minute with a minimum web tension and then increasing the web tension at a constant web speed of 600 feet per minute. With three of the mediums that did not run on the corrugator, polyethylene was applied. To do this two polyethylene bars were mounted on the corrugator such that each side of the medium was in continuous contact with one of them. A minute quantity of the bar material was transferred to the medium, supposedly altering the frictional resistance between the medium and the corrugating rolls.

Results and Discussion

Most of the experimental corrugating mediums had reasonable properties in both compression and tension (tables 3 and 4), but only a few could be corrugated at a reasonable speed without fracturing. Those made with neutral sulfite semichemical pulps (table 3) fractured at less than 20 feet per minute. This was noted with both the Colombian mixture and mixture from the three countries. Decreasing pulp yield from 74 to 65 percent, refining the pulp more for better bonding, lowering the headbox consistency to give a better formed medium, or adding 25 percent hardwood kraft pulp did not improve the runnability. However, the neutral sulfite semichemical mediums did run successfully when oleic acid was added to the pulp furnish or when the polyethylene bars were used.

The medium made with the screening rejects from the mixed Colombian hardwood high-yield kraft pulp was successfully corrugated as was the medium made with the screen accepts from this same pulp. However, when a kraft semichemical pulp was cooked to the same Kappa number as the screening rejects, the resultant medium could not be corrugated at 20 feet per minute without fracturing. Employing the same pulping conditions with the mixture from the three countries, the medium ran at less than 400 feet per minute. Increasing the sulfidity from 25 to 50 percent when pulping the Colombian mixture had no effect on the medium's ability to run on the corrugator. The polyethylene bars were tried successfully with just one of the kraft mediums which previously did not run.

The mediums made with the green liquor pulps containing the Colombian mixture did not corrugate when the amount of alkali in pulping was comparable to that used commercially today with this type semichemical pulp. When the effective alkali in the green liquor cook was increased to the level of that used in the kraft semichemical cooks, the medium had improved corrugating characteristics. With the wood mixture from the three countries and the lower alkali level in the green liquor cook, the medium had good corrugating characteristics.

The only soda carbonate medium made could not be corrugated at 20 feet per minute without fracturing.

The physical properties presented in tables 3 and 4 give no indication for the differences in runnability noted with the various experimental machines. Thus, selected mediums with both good and poor running

characteristics were analyzed microscopically, chemically, and for surface frictional resistance. Again no relationship was indicated. Microscopic examinations included both surface appearance as well as formation differences as shown with transparent microscopy. Ash, silica, extractives, and elemental determinations were made. Except for ash, only small quantities of a given chemical component were present. Two surface friction tests were tried with neither indicating causes for the large differences noted in runnability.

Conclusions

1. Corrugating mediums with good quality, as measured by the usual paperboard tests made on this product, can be made from mixed tropical hardwood semichemical pulps using either the neutral sulfite, kraft, green liquor, or soda-carbonate pulping processes.

2. There exists a severe problem in running these mediums through the corrugator which can, apparently, be overcome by the addition of a lubricant.

3. Further research is needed to identify the cause of poor runnability performance of mediums made from mixed tropical hardwood semichemical pulps.

4. Further research is also needed to develop better test methods for predicting the runnability of corrugating mediums.

Table 1.--Composition of mixture containing Philippine, Ghanaian, and Colombian species

Common name	Specific gravity	Amount in mixture
PHILIPPINE SPECIES		
Tangisang-bayauak	0.236	0.6
Ilang-ilang	.308	.4
Anabiong	.319	1.9
Hamindang	.324	5.5
Balanti	.356	.5
Tulo	.401	.5
Tangile	.429	.8
Apanit	.447	1.2
Antipolo	.469	.3
Bagtican	.478	.9
Sakat	.485	1.7
Red lauan	.510	1.4
Itangan	.526	2.2
Piling-liitan	.549	1.8
Mixture A	.505	.5
Mixture B	.643	8.7
Equal mixture of Tangisang-bayauak Binuang Kapok	.240	1.0
Equal mixture of Mayapis Malasantol White lauan	.392	1.0
Equal mixture of Lamarau Malabetis Dangtalan	.562	.4
Equal mixture of Yakal Kamagong Katong-matsin	.721	.5
Equal mixture of Tangisang-Bayauak Ilang-ilang Anabiong Hamindang Balanti Tulo Tangile Bagtican	.359	.7

Table 1.--Composition of mixture containing Philippine, Ghanaian, and Colombian species--continued

Common name	Specific gravity	Amount in mixture
	GHANAIAN SPECIES	
Antiaris	0.312	0.6
Canarium	.337	1.3
Akoret	.370	4.0
African mahogany	.413	.8
Scented guarea	.485	2.3
Makore	.499	1.1
Tallow tree	.540	1.4
Lokonfi	.549	2.3
Brown stercula	.552	1.5
Eyong	.589	3.8
Adjouba	.692	1.3
Afina	.697	3.4
Kane	.708	1.8
Kokoti	.721	3.5
Ekki	.808	1.8
Mixture A	.470	5.3
Mixture B	.604	2.2
Mixture C	.487	2.4
	COLOMBIAN SPECIES	
Carbonero	.634	3.1
Carreto	.692	3.1
Lecheperra	.785	7.7
Tamarindo	.823	5.4
Mixture B	.667	.5
Mixture C	.544	.8
Equal mixture of		
Ceiba		
Yarumo		
Cirpo		
Chingale	.304	2.7
Equal mixture of		
Ceiba		
Yarumo		
Cirpo		
Chingale		
Dormilon		
Sande		

Table 1.--Composition of mixture containing Philippine, Ghanaian, and Colombian species--continued

Common name	Specific gravity	Amount in mixture
Sangretoro		
Arenillo		
Canello		
Perillo negro	0.473	1.7
Equal mixture of		
Ceiba		
Yarumo		
Cirpo		
Chingale		
Dormilon		
Sande		
Sangretoro		
Arenillo		
Canello		
Perillo negro		
Casaco		
Carbonero		
Chocho		
Carreto	.493	1.8

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Table 2.--Pilot scale semichemical pulping of tropical hardwood mixtures for papermachine and corrugating runnability trials

Wood mixture	Digestion Nos.	Chemicals charged[1]				Liquor to wood ratio	Cooking temperature	Time to temperature	Time at temperature	Spent liquor				Kappa Nos.	Estimated yield[2]	Papermachine run Nos.
		Na_2SO_3	Na_2CO_3	NaOH (Na_2O)	Na_2S (Na_2O)					Na_2SO_3	NaOH (Na_2O)	Na_2S (Na_2O)	pH			
		Pct	Pct	Pct	Pct		°C	Min	Min	G/L	G/L	G/L			Pct	
							NEUTRAL SULFITE[3]									
Colombian	2549 2550	16.0	4.0	--	--	3.5	175	120	90	15.0	--	--	8.5	--	74	7157
Colombian	2551 2552	16.0	4.0	3.0	--	3.5	175	120	70	13.1	--	--	9.8	--	74	7158
Colombian	2553 2554	18.0	4.5	--	--	3.5	175	120	230	--	--	--	8.7	--	65	7159
Colombian	2555	18.0	4.5	--	--	3.5	175	120	230	10.3	--	--	8.7	127	65	7166
Colombian	2573 2574	18.0	--	--	5.0	3.5	170	120	30	17.9	--	5.7	10.3	128	65	7183
PGC[4]	2556-2567	18.0	4.5	--	--	3.5	175	120	230	10.3	--	--	8.7	132	66	7169-7175
PGC	2568	16.0	4.0	--	--	3.5	175	120	90	--	--	--	--	--	74	7179
							KRAFT									
Colombian	4590-4595	--	--	12.0	4.0	4	168	80	5	--	6.8	7.7	--	[5]85 [6]130	57 65	7168 7160
Colombian	4596	--	--	9.0	3.0	4	165	60	5	--	6.0	6.0	--	142	67	7163
Colombian	4618 4619	--	--	5.0	5.0	4	170	90	10	--	0	10.7	11.3	132	66	7182
PGC	4605 4606	--	--	9.0	3.0	4	165	60	5	--	--	--	--	142	67	7176
PGC	4607 4608	--	--	10.5	3.5	4	170	60	10	--	4.3	7.6	9.9	90	59	7177
							GREEN LIQUOR									
Colombian	4597	--	106	--	21.0	4	165	60	5	--	--	45.0	13.0	99	60	7164
Colombian	4598	--	106	--	21.0	4	165	60	5	--	--	53.0	12.9	98	60	7165
Colombian	[3]4616 4617	--	20.0	2.5	7.5	3.5	170	60	180	--	0	15.7	10.2	113	62	7181
Colombian	[3]4621	--	24.0	3.0	9.0	3.5	170	60	180	--	--	--	--	80	56	7185
PGC	[3]4609 4610	--	20.0	2.5	7.5	3.5	170	60	180	--	--	15.0	10.0	96	60	7178
							SODA-CARBONATE									
Colombian	[3]2576	--	16.0	10.0	--	3.5	170	90	60	--	13.3	--	12.6	152	69	7184

1/ Moisture free wood basis.
2/ Based on similar small scale digestions and Kappa number.
3/ Chips were presteamed for 15 min. at 15 lb/in.^{2}g.
4/ Mixture of Philippine, Ghanaian, and Colombian hardwoods.
5/ Screened pulp.
6/ Fiberized screenings.

Table 3.--Properties of corrugating medium made from mixed tropical hardwood neutral sulfite semichemical pulps

Machine run No.	Wood mixture[1/]	Furnish: Stuff freeness (CSF)	Furnish: Headbox consistence	Sheet properties[2/]: Weight (sq m)	Weight (1,000 sq ft)	Thickness	Density	Bursting strength	Tearing resistance MD	Tearing resistance CD	Folding endurance MD	Folding endurance CD	Porosity (1/4-in. orifice)	Water absorbency (0.1 cc)	Castor oil penetration	Ring crush MD	Ring crush CD	Concora	Tensile strength[3/]: Maximum strength MD	Maximum strength CD	Modulus of elasticity MD	Modulus of elasticity CD	Strain to fail MD	Strain to fail CD	Pycnometer thickness	Runnability: Speed	Runnability: Tension
		Ml	Pct	G	Lb	Mil	G/cc	Pt	G	G	Double folds	Double folds	Sec/100 cc	Sec	Sec	Lb	Lb	Lb	Lb/in.²	Lb/in.²	1,000 lb/in.²	1,000 lb/in.²	Pct	Pct	Mil	Fpm	Pli
NEUTRAL SULFITE																											
7157	Colombian	350	0.72	126.9	26.0	9.5	0.52	41.5	91.6	105.6	34	35	23.6	12.2	--	72.4	56.4	67.1	5,170	2,890	650	315	2.06	3.29	8.2	4/ 20	0.3
7158	...do....	305	.72	128.0	26.2	9.9	.51	34.3	103.2	101.2	35	24	25.6	13.4	--	64.0	53.7	60.4	3,930	2,820	578	304	1.75	3.74	8.4	20	.3
7159	...do....	355	.85	126.9	26.0	9.3	.54	44.2	116.0	113.2	70	56	22.8	10.6	--	72.7	56.9	66.0	5,200	3,350	704	367	1.81	3.67	8.0	20	.3
7166	...do....	350	.84	118.3	24.2	8.9	.52	44.2	93.6	112.8	81	56	31.2	17.5	--	67.1	51.4	70.3	5,790	3,220	709	366	2.03	4.01	7.5	4/ 70	.3
7183	...do....	300	.58	128.2	26.3	9.0	.56	48.3	118.4	120.8	163	83	52.6	75.6	97.5	61.4	50.9	73.6	5,600	3,100	797	342	2.21	4.95	7.7	20	.3
7169	PGC	360	.98	129.5	26.5	10.7	.48	36.8	108.8	115.2	43	29	25.3	17.3	166.1	65.6	52.2	62.3	4,440	2,930	599	353	1.44	2.55	8.4	70	.3
7170	PGC	360	.60	126.5	26.0	9.8	.51	54.1	101.2	118.4	94	42	25.8	21.4	141.7	64.9	48.6	66.6	6,000	3,060	704	326	1.85	3.80	8.1	20	.3
7171	PGC	310	.59	126.9	26.0	9.4	.53	57.7	104.8	126.0	129	55	40.6	24.0	183.1	64.7	49.9	71.1	6,780	3,410	768	362	2.07	3.91	7.7	20	.3
7172	PGC	250	.58	126.7	26.0	9.3	.54	59.8	104.8	120.4	188	75	69.3	34.3	300+	62.0	47.9	72.7	6,660	3,540	685	354	2.32	4.55	7.6	20	.3
7173	PGC	300	.52	126.9	26.0	9.4	.53	59.7	109.6	120.8	131	67	60.0	30.0	203+	64.9	50.2	73.9	6,580	3,570	694	360	2.34	4.16	7.8	20	.3
7174[5/]	PGC	310	.62	130.6	26.8	9.9	.52	53.6	97.2	116.4	125	47	61.4	23.9	300+	77.3	56.5	79.5	6,280	3,080	758	321	2.22	4.20	8.5	20	.3
7175[5,6/]	PGC	320	.61	126.9	26.0	10.0	.50	40.4	94.8	104.0	64	34	28.9	10.9	165.0	69.2	56.0	57.8	5,360	2,900	689	332	1.72	3.52	8.2	600	1.5
7179[7/]	PGC	300	.63	126.9	26.0	9.0	.55	55.5	106.8	112.0	170	110	72.7	27.1	182+	57.8	48.0	72.6	6,500	3,540	707	339	2.30	4.35	7.6	20	.3

1/ PGC is a mixture of Philippine, Ghanaian, and Colombian hardwoods.
2/ Tests were made according to TAPPI standard methods except as noted.
3/ Tests made with a universal tester equipped with an electrical load cell.
4/ Ran at speed in excess of 500 ft/min when the polyethylene bar was used on both sides of the medium.
5/ Broke from MR's 7169-73.
6/ Added 0.25 pct oleic acid.
7/ Pulp furnish contained 25 pct kraft pulp made with PGC wood mixture.

Table 4.--Properties of corrugating medium made from mixed tropical hardwood semichemical pulps

Machine run No.	Wood mixture[1/]	Furnish: Stuff freeness (CSF)	Furnish: Headbox consistence	Sheet properties[2/]: Weight (sq m)	Weight (1,000 sq ft)	Thickness	Density	Bursting strength	Tearing resistance MD	Tearing resistance CD	Folding endurance MD	Folding endurance CD	Porosity (1/4-in. orifice)	Water absorbency (0.1 cc)	Castor oil penetration	Ring crush MD	Ring crush CD	Concora	Tensile strength[3/]: Maximum strength MD	Maximum strength CD	Modulus of elasticity MD	Modulus of elasticity CD	Strain to fail MD	Strain to fail CD	Pycnometer thickness	Runnability: Speed	Runnability: Tension
	Ml	Ml	Pct	G	Lb	Mil	G/cc	Pt	G	G	Double folds	Double folds	Sec/100 cc	Sec	Sec	Lb	Lb	Lb	Lb/in.[2]	Lb/in.[2]	1,000 lb/in.[2]	1,000 lb/in.[2]	Pct	Pct	Mil	Fpm	Pli
													KRAFT														
7160	Colombian	290	0.73	122.9	25.2	9.2	0.52	32.6	108.0	110.0	57	36	23.7	18.7	--	62.9	47.8	53.0	4,380	2,550	620	310	1.58	3.66	8.1	500	1.0
7168	...do....	330	.61	126.9	26.0	8.5	.59	44.0	134.8	135.2	79	38	43.7	27.9	--	55.7	44.1	55.1	5,470	3,070	705	358	2.23	4.32	7.4	550	[illegible]
7163	...do....	365	.71	131.6	27.0	9.6	.54	35.6	119.6	114.0	50	41	33.9	20.6	--	70.8	50.5	60.7	4,590	3,000	650	344	1.59	3.90	8.0	4/ 20	.3
7182	...do....	290	.57	123.4	25.3	8.5	.57	45.2	108.8	115.2	155	78	54.1	110.9	120	57.7	45.3	69.4	5,890	3,120	682	338	2.30	5.03	7.2	20	.3
7176	PGC	310	.61	126.2	25.9	9.2	.54	47.5	100.0	113.6	197	67	59.0	25.1	155+	59.4	47.0	68.3	5,360	3,090	563	303	2.64	5.04	7.7	500	.3
7177	PGC	290	.63	127.3	26.1	8.5	.59	59.3	131.2	136.4	701	259	99.3	71.3	175+	57.7	48.0	70.3	6,650	4,270	706	403	2.80	5.71	7.2	20	.3
													GREEN LIQUOR														
7164	Colombian	260	.50	119.0	24.4	8.8	.53	42.2	116.0	124.4	209	98	39.3	40.0	--	59.6	49.2	70.1	5,280	3,150	719	338	2.16	5.69	7.2	600	[illegible]
7165	...do....	330	.51	124.7	25.6	9.3	.53	40.2	124.0	128.4	108	96	24.0	23.4	--	67.6	52.8	70.0	4,910	3,010	688	365	1.86	4.45	7.6	600	.7
7181	...do....	300	.60	126.9	26.0	8.4	.60	45.6	124.8	126.8	182	104	77.8	30.1	180+	57.0	47.1	64.4	5,740	3,330	689	344	2.50	6.33	7.3	20	.3
7185	..do....	290	.59	130.8	26.8	8.7	.59	53.2	141.2	148.0	400	135	62.7	33.1	73	56.2	49.0	38.7	6,760	3,750	994	395	1.94	5.54	7.1	20	.3
7178	PGC	250	.64	132.8	27.2	8.7	.60	62.2	141.2	149.6	324	132	104.6	75.0	300+	59.0	47.4	74.0	7,110	3,740	832	383	2.79	5.86	7.3	600	3.0
													SODA CARBONATE														
7184	Colombian	300	.60	128.2	26.3	10.8	.47	31.3	99.2	98.8	31	18	21.9	11.7	55	64.0	49.4	53.5	3,960	2,200	577	255	1.64	3.90	9.2	20	3

1/ PGC is a mixture of Philippine, Ghanaian, and Colombian hardwoods.
2/ Tests were made according to TAPPI standard methods except as noted.
3/ Tests made with a universal tester equipped with an electrical load cell.
4/ Ran at speed in excess of 500 ft/min when the polyethylene bar was used on both sides of the medium.

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